SECTION 15485 - MEDICAL GAS PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes tubing, piping, and related accessories for the following medical gas systems and dental gas systems.
   1. Oxygen systems, designated "oxygen" and "O".
   2. Medical compressed air systems, designated "air" and "A".
   3. Nitrous oxide systems, designated "nitrous oxide" and "NO".
   4. Medical-surgical vacuum systems, designated "vacuum" and "VAC".
   5. Dental vacuum systems, designated "dental vac" and "DV".
   6. Dental compressed air systems, designated "dental air" and "DA".

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 11 Section "Patient Wall Systems" for medical equipment and outlets requiring medical gas services.
   2. Division 15 Section "Medical Gas Systems Equipment" for medical gas system equipment and accessories.

C. Unless specified otherwise herein, materials, workmanship, and execution of dental gas systems shall be equal to medical gas systems of similar nature.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Installer Qualifications: Engage an experienced installer of medical gas systems.
   1. The term "experienced installer" is specified in Division 1 Section "Reference Standards and Definitions."

B. Provide medical gas piping systems complying with requirements of NFPA 99 "Standard for Health Care Facilities."

C. Provide compatible accessories, tube, fittings, and valves for each system.

D. Testing Agency Qualification: Engage an experienced testing agency for certification of the medical gas pipeline. Certification shall include freedom from both leaks and cross connections.
   1. The testing agency shall be a firm independent of the installing firm. It shall be either one which specializes in such work with at least five projects of similar size and scope completed in the last year, or an agent authorized by the manufacturer of the medical gas source equipment.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for the following:
   1. Special purpose valves.
   2. Medical gas outlets.
   3. Medical gas accessories.
   4. Medical gas alarm system components.

C. Wiring diagrams for medical gas alarm systems and tanks. Include ladder-type wiring diagrams for interlock and control wiring required for

final installation. Differentiate between portions of wiring that are factory installed and portions that are field installed.

D. Coordination drawings for medical gas systems.

E. Inspection and test reports specified in "Field Quality Control" in this Section.

F. Certificates of inspections and tests from independent testing agency specified in "Field Quality Control" in this Section.

G. Maintenance data for inclusion in Operating and Maintenance Manuals.

H. Qualifications of the pipeline testing and certifying agency.

I. Preventive maintenance guide and checklist cards and equipment cards on each item of equipment as required in Division 1.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the inspection and testing indicated without delaying the progress of the Work.

B. Comply with NFPA 70 "National Electrical Code."

C. Comply with NFPA 99 "Standard for Health Care Facilities."

D. Comply with UL 498 "Standard for Attachment Plugs and Receptacles."

E. Comply with UL 544 "Standard for Medical and Dental Equipment."

F. NRTL Listing and Labeling: Provide equipment that is listed and labeled.
1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store large medical gas accessories on factory-installed shipping skids, tubing with sealing plugs in ends or with end protection, and small accessories in factory-fabricated fiberboard containers.
1. Store precleaned and sealed medical gas tube, fittings, valves, and accessories with sealing plugs and sealing packaging intact.
2. Label medical gas tube, fittings, valves, and accessories that have not been precleaned, and that have been precleaned but have seal or packaging that is not intact, with temporary labels indicating that cleaning is required before installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
1. Medical Gas Systems Accessories:
a. Chemetron Div.; Allied Healthcare Products, Inc.
b. Ohmeda Medical Engineering Div.; BOC Group, Inc.
c. Puritan Group; Puritan-Bennett Corp.

2. Medical Gas Alarm Systems:
a. Chemetron Div.; Allied Healthcare Products, Inc.
b. Ohmeda Medical Engineering Div.; BOC Group, Inc.
c. Puritan Group; Puritan-Bennett Corp.

2.2 MEDICAL GAS TUBING, GENERAL

A. Copper Tube, Fittings, Valves, and Piping Components: Factory-cleaned, -purged, and -sealed, and marked or labeled "CLEANED FOR MEDICAL GAS SERVICE," "CLEAN FOR OXYGEN SERVICE."

1. Components required, but not available cleaned for medical gas use, may be provided, but must be cleaned before use as specified below under "PREPARATION."

B. Pipe joining materials, specialties, and basic installation requirements are specified in Division 15 Section "Basic Materials and Methods."

2.3 MEDICAL GAS TUBE

A. Soft Copper Tube: ASTM B 88, Type K, water tube, seamless, annealed temper.

B. Precleaned and Sealed Copper Tube: ASTM B 88, Type K or Type L, water tube, seamless, drawn temper, cleaned for medical gas use, purged, and with ends sealed.

2.4 MEDICAL GAS TUBE FITTINGS

A. Wrought-Copper Fittings: ASME B16.22, solder-joint, pressure type.

B. Flexible Connectors: Bronze or stainless-steel flexible pipe connectors as specified in Division 15 Section "Mechanical Vibration, and Seismic Control."

2.5 MEDICAL GAS TUBING JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8, BCuP (copper-phosphorus) Series alloys. Flux is prohibited, except when used with bronze fittings.

B. Threaded-Joint Tape: Polytetrafluoroethylene (PTFE) plastic.

C. Gasket Material: ASME B16.21, nonmetallic, flat, asbestos-free, and suitable for oxygen use.

2.6 VALVES

A. Ball Valves: Bronze-body, full-flow, chrome-plated brass ball valve, with Buna-N or TFE seat seals and stem seals, blow-out-proof stem, threaded or braze-joint ends, locking-type handle, designed for quarter turn between open and closed positions and for 300 psi (2069 kPa) working pressure.
   1. Provide union-type body with bolted swing-away center section.

B. The following zone valve boxes are identified on the plans and Medical Gas Equipment Schedule as ESO-x, Emergency Shut-Off, with box and valves provided as one complete unit.
   1. Zone Valve Boxes: Minimum .05 inch (1.3 mm) steel or minimum .075 inch (1.9 mm) sheet metal or extruded aluminum valve boxes for recessed mounting, with holes for medical gas tubing and anchors. Provide for single or multiple valve (with gage) installation and in sizes to permit manual operation of valves.
      a. Interior Finish: Factory-applied white enamel.

b. Cover Plate: Satin chrome finish, .050 inch (1.3 mm) steel, .075 inch (1.9 mm) extruded anodized aluminum, or .032 inch (.85 mm) stainless steel with NAAMM AMP 503, No. 4 finish. Provide frangible or removable windows.

c. Valve Box Windows: Thick, clear or tinted transparent plastic with factory-installed or field-installed labeling (including space for rooms served) in accordance with NFPA 99.

2.7 MEDICAL GAS SYSTEM ACCESSORIES

A. General: Provide the following medical gas system accessories by the same manufacturer.

B. The following Service Outlets are identified on the plans and Plumbing Fixture

Schedule as MGO-x, Medical Gas Outlets, and are provided complete with box, outlet,

cover plate, and hose assembly.

1. Medical Gas Outlets: Include brass valve and body block with seals in roughing-in and finishing assemblies, steel outlet box and cover plate;

3/8 inch (10 mm) Type K copper tube brazed to valve; and pressure outlets with automatic secondary service valve to prevent gas flow when primary valve is removed.

a. Quick-Connect Coupling: Indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment with positive locking ring which retains equipment stem in valve during use. For oxygen, nitrous oxide, compressed air and vacuum.

b. Wall Outlet Cover Plates: One piece, stainless-steel plate with NAAMM AMP 503, No. 4 finish; metal with chrome plated finish; or anodized aluminum with permanent, color-coded, medical gas identifying label matching corresponding outlets.

c. Vacuum Bottle Slide Brackets: Bottle slide and mounting assembly matching pattern of vacuum outlet. Provide 1 slide bracket for each vacuum inlet where indicated.

B. Service Hose Assemblies: Color-coded, conductive, neoprene, .25 inch (6 mm) or .3125 inch (8 mm) inside diameter, of lengths indicated, and with indexed end-connection fittings as indicated, suitable for medical gas service indicated.

1. Oxygen, nitrous oxide, compressed air and vacuum hose assemblies 8 feet (2.44 meters) long, with quick-connect oxygen fittings, valve on one end and stem on other end.

2.8 MEDICAL GAS ALARM SYSTEM

A. The following Medical Gas Alarm Systems are identified on the plans and Medical Gas Equipment Schedule as MGA-x, Medical Gas Alarm.

B. General: Provide medical gas alarm system consisting of compatible alarm panels, remote sensing devices, and other related components where indicated and where required by NFPA 99. Power and wiring is specified in Division 16.

C. Components: Designed for continuous service and to operate on power supplied from 120-V power source to alarm panels and have connections for 24-V or 12-V a.c. low-voltage wiring to remote sensing devices. Provide step-down transformers where required.

D. Provide pressure and vacuum switches or pressure transducer sensors for continuous line monitoring with electrical connections for alarm system.

1. Low-Pressure Switches: 5 to 100 psi (34 to 690 kPa) operating range, with high and low pressure signal.
2. High-Pressure Switches: Up to 250 psi (1724 kPa) operating range, with high and low pressure signal.
3. Vacuum Switches: 0 to 30 inches (0 to 762 mm) Hg. range.

E. Alarm Panels: Factory-wired with audible and color-coded visible signals to indicate specified functions.

F. Mounting: Recessed installation.

G. Enclosures: Constructed of .05 inch (1.3 mm) steel or aluminum, and with knockouts for electrical and tubing connections.

H. Provide manufacturer's standard features and include the following special features (when not manufacturer's standard):

1. Master Alarm Panels (MGA-1): Provide separate trouble alarm signals, pressure (vacuum) gages, and indicators for oxygen, air, vacuum, and nitrous oxide. Provide signal alarms at master alarm panels when the following conditions exist.
   a. Oxygen: Pressure downstream of main shutoff valve drops below 40 psi (276 kPa); rises above 60 psi (414 kPa); or changeover is made to alternate bank.
   b. Air: Pressure drops below 40 psi (276 kPa) or rises above 60 psi (414 kPa); backup air compressor is in operation; pressure drop across filter assembly increases more than 2.0 psi (14 kPa); dew point rises above 40°F (3.9 deg C) at 54psi (379 kPa); or carbon monoxide level rises above 10 parts per million.
   c. Vacuum: Pressure drops below 12 inches (305 mm) Hg.; backup vacuum pump is in operation.
   d. Nitrous Oxide: Pressure drops below 40 psi (276 kPa); rises above 60 psi (414 kPa); or changeover is made to alternate bank.

2. Area Alarm Panels (MGA-2): Provide separate trouble alarm signals; pressure (vacuum) gages; and indicators for oxygen, air, vacuum and nitrous oxide as indicated by service, shown on plans to each MGA-2. Provide remote alarm contacts for each alarm condition.

3. Signal alarms at area alarm panels and at anesthetizing area alarm panels when the following conditions exist.
   a. Oxygen: Pressure drops below 40 psi (276 kPa) or rises above 60 psi (414 kPa).
   b. Air: Pressure drops below 40 psi (276 kPa) or rises above 60 psi (414 kPa).
   c. Vacuum: Pressure drops below 12 inches (305 mm) Hg.
   d. Nitrous Oxide: Pressure drops below 40 psi (276 kPa) or rises above
      60 psi (414 kPa).
   e. Pressure drops below 40 psi (276 kPa) or rises above 60 psi (414 kPa).

I. Electrical connection of area alarm contacts to remote alarm (nurses' call) is specified in Division 16.

2.9 IDENTIFICATION

A. Refer to Division 15 Section "Mechanical Identification" for piping (both underground and within building), tubing, valves, gages, alarms, and accessories.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Where factory-precleaned and capped tubing and piping are not available, or when precleaned tubing and piping must be recleaned because of exposure, perform the following procedures:

1. Clean all medical gas pipe and pipe fittings, tube and tube fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service, in accordance with CGA G-4.1-85 "Cleaning Equipment for Oxygen Service."
2. Wash medical gas piping, tubing, and components in a hot alkaline cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of one pound of chemical to three gallons of water.
   a. Scrub to ensure complete cleaning.
   b. Rinse with clean hot water after washing to remove cleaning solution.

3.2 TUBING APPLICATIONS

A. General: Refer to Part 2 of this Section for the following materials.

B. Interior: Use "Precleaned and Sealed Copper Tube" with wrought copper fittings and brazed joints. Use soft copper tube with wrought copper fittings and brazed joints in sizes less than 1/2 inch (15 mm).

3.3 TUBING JOINT CONSTRUCTION

A. Requirements for brazed, threaded, and flanged joint construction are specified in Division 15 Section "Basic Piping Materials and Methods."

3.4 CASING JOINT CONSTRUCTION

A. Join PVC protective casing pipe and fittings with threaded or solvent cement joints.
   1. Threaded Joints: Conform to ASME B1.20.1, "Tapered Pipe Threads" for field-cut threads. Join pipe and pipe fittings as follows:
      a. Note the internal length of threads in fittings and proximity of internal seat to determine how far pipe should be threaded into fitting.
      b. Align threads at point of assembly.
      c. Damaged Threads: Do not use pipe with damaged threads.

   2. Solvent Cement Joints: Conform to ASTM D 2855.

3.5 TUBING INSTALLATION, GENERAL

A. Basic installation requirements are specified in Division 15 Section "Basic Piping Materials and Methods."

B. Install supports and anchors in accordance with Division 15 Section "Supports and Anchors."
   1. Spacing Between Hangers: As described in NFPA 99.

C. Valve Applications: Use ball valves specified in this Section for main shutoff and zone valve duties.

D. Install zone valves in valve box anchored to structure. Install valves at angle that prevents closure of cover when valve is in closed position. A single box may be used for multiple valves when valves serve same area or same function.

E. Install thermometers and pressure gages in accordance with Division 15 Section "Meters and Gages."

F. Install buried medical gas tubing in a conduit fabricated with PVC pipe and fittings. Do not extend casing through foundation wall.

G. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.

3.6 ACCESSORIES INSTALLATION

A. Install accessories in accordance with NFPA 99 and manufacturer's printed installation instructions.

3.7 MEDICAL GAS ALARM SYSTEM INSTALLATION

A. General: Install alarm system components in accordance with NFPA 99 and manufacturer's printed installation instructions.

B. Install alarm panels in locations indicated.

3.8 CONNECTIONS

A. Install tubing and piping adjacent to equipment to allow servicing and maintenance.

B. Connect medical gas tubing to equipment, gas manifolds, and accessories with unions. Install with ball valves and strainers.
   1. Install flexible pipe (tubing) connectors on air tubing connections to medical air compressors, vacuum tubing connections to medical vacuum pumps, and where indicated.
   2. Where not included by manufacturer of Medical Air Compressor and Medical Vacuum Pump:
      a. Install thermometers on medical air compressor discharge tubing, medical air receiver tanks, medical vacuum receiver tanks, and where indicated.
      b. Install pressure gages on medical air compressor discharge tubing, air receiver tanks, vacuum receiver tanks, and where indicated.
      c. Install pressure regulators downstream from medical air system compressors, dryers, purification units, and filter assemblies.

C. Install medical gas tubing and electrical connections to medical gas alarm system components.

D. Electrical Connections: Power wiring and disconnect switches are specified in Division 16 Sections "Wires and Cables" and "Circuit and Motor Disconnects."
   1. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.9 LABELING AND IDENTIFICATION

A. Install labeling on valves, valve box covers, and alarm panels in accordance with requirements of NFPA 99.

B. Captions and Color Coding: Use the following or similar medical gas captions and color coding for accessories, when specified and where required by NFPA 99.
   1. Oxygen: White letters on green background.
   2. Air: Black or white letters on yellow background.
   3. Vacuum: Black letters on white background.
   4. Nitrous Oxide: White letters on blue background.

3.10 FIELD QUALITY CONTROL

A. System Clearing: Purge medical gas system tubing using nitrogen after installation of tubing but before installation of service outlet valves, alarms, and gages.

B. Pressure Test: Subject each section of each system to test pressure of from 150 psi to 200 psi (1034 kPa to 1379 kPa) and nitrogen systems to test pressure of 250psi (1724 kPa) with nitrogen before attachment of system components, after installation of station outlets with test caps (when supplied) in place, and before concealing piping system. Maintain test until joints are examined for leaks by means of soapy water.

C. Standing-Pressure Test: Install assembled system components after testing individual systems as specified above. Subject systems to 24-hour standing-pressure test at 20 percent above normal line pressure but not less than 65 psi (455 kPa). Subject vacuum and evacuation systems to 12 to 18 inches (304 to 457 mm) of mercury minimum vacuum in lieu of pressure test.

D. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

E. Repair medical gas systems and replace components that fail tests specified.

F. Independent Testing Agency Services: Provide services of an independent testing agency meeting requirements of this section and of Division 1 Section "Quality Control Services" to inspect, test, and certify medical gas systems as specified below. Testing agency work does not include Installer quality control procedures or tests.

1. Inspect, test, and certify complete medical gas systems in accordance with the requirements of NFPA 99, Standard for Health Care Facilities. Inspect, test, and certify each medical gas system, including each tubing system, outlets and inlets, accessories, alarm panels and devices, safety devices, medical gas sources, and equipment.

2. Provide nitrogen, materials, equipment, and labor required for testing.
3. Provide medical gases required for systems testing.
4. Prepare written reports of tests results including corrective action. Include copy of reports in O & M Manuals.
5. Certify that medical gas systems comply with requirements specified, that tests were properly performed, and that test results were satisfactory. Provide Contracting Officer with one copy of certification. Include copy of certification in O & M Manuals.
6. Inspect outlets and inlets, gages, alarms, and zone valves for proper labeling for gas service and function.
7. Inspect manifold supply systems for installation and operation as required by NFPA 99, Chapter 4.
8. Phase I Tests: Perform the following tests using dry air or nitrogen after installation of gas systems is complete.
   a. Outlet and Inlet Cross-Connection Test-Testing Agency Option:
      1) Pressurize one medical gas system to 50 psi (345 kPa), with other systems at atmospheric pressure, and access each outlet with an appropriate adapter and test gage. Repeat procedure for each system.

2) Pressurize each system in 10 psi (69 kPa) increments and access each outlet with an appropriate adapter and test gage.

b. Alarm System Test: Test for operation of functions specified in article "Medical Gas Alarm System," within limits required.

c. Pressure Test: Test systems at operational pressure with system components installed. No leaks allowed. Conduct tests by zone.

d. Particulate Sampling: Test positive pressure terminal outlets, using a 0.45-micron filter, for evidence of solid particulate contamination. Allowable limit is .0009 grains per cubic foot (2 mg. per cubic meter).

e. Moisture: Test positive pressure terminal outlets for dew point to verify absence of moisture in piping. Dew point of gas dispensed from terminal outlets shall not exceed dew point of source test gas by more than 6ºF (-15.6 deg C).

f. Systems Purity: Test terminal outlets and test gas source for contaminant levels as defined below. Excessive contaminant levels will require additional purging to outlets within a specific zone until levels are within the following limits.
   1) Total Hydrocarbons as Methane: 1 part per million.
   2) Halogenated Hydrocarbons: 2 parts per million.
   3) Carbon Monoxide: 2 parts per million.

g. Air Compressor Purity: Collect medical air compressor air samples taken from downstream side of filters and air dryers. Test samples for contaminants and moisture within the following limits.

   1) Total Hydrocarbons as Methane: 25 parts per million.
   2) Halogenated Hydrocarbons: 5 parts per million.
   3) Carbon Monoxide: 10 parts per million.

4) Moisture (Dew Point): Plus 40° F (4 deg C) at dryer discharge.

5. Phase II Tests: After Phase I testing has been completed, test completed medical gas systems using applicable medical gas for each system. Completed systems have outlets and inlets, alarms, and gages installed; and gas supply systems installed and ready for operation.
   a. Final Purging: Introduce applicable medical gas for each system into respective piping systems. Purge installed outlet valves to remove nitrogen test gas present from Phase I testing. Test vacuum inlets for ability to flow.
   b. Outflow Analysis: Analyze medical gas at each positive pressure outlets to confirm delivery of proper medical gas at proper concentration level. Minimum allowable concentration levels are defined by the U.S. Pharmacopoeia XXII/National Formulary XVII (USP/NF) and the following CGA Commodity Specifications.
      1) CGA G-4.3, Commodity Specification for Oxygen.
      2) CGA G-7.1, Commodity Specification for Air.
      3) CGA G-8.2, Commodity Specification for Nitrous Oxide.
      4) The U.S. Pharmacopoeia XXII/National Formulary XVII is available from the U.S. Pharmacopoeia, 12601 Twinbrook Pkwy., Rockville, MD 20852.

   c. Systems Delivery Pressures: Test pressure piping systems to confirm supply sources are set to deliver gas at following nominal pressure levels.
      1) All Systems: 50 - 54 psi (345-379 kPa) at maximum flow.
      2) Nitrogen: 160 psi (1103 kPa) minimum at maximum flow.

d. Systems Suction Levels: Test vacuum and evacuation piping systems to confirm that vacuum producers are set to maintain suction of not less than 12 inches (300 mm) of mercury at most distant inlets.

6. Testing Agency Certification: Certify that specified inspection, tests, and procedures have been performed and report results. Include the following certification in the O & M Manuals.
   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Tests methods used.
   d. Results of tests.

3.11 COMMISSIONING

A. Provide the services of a factory-authorized service representative to inspect alarm system installation and to provide start-up service.

B. Operate and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment discovered by the service representative.

C. Checks Before Start-up: Perform the following final checks before start-up:
   1. Verify that specified tests of piping systems are complete.
   2. Check that safety (pressure-relief) valves have correct setting that is greater than medical air compressor discharge pressure, but not greater than pressure rating of system components.

3.12 DEMONSTRATION AND TRAINING

A. Provide the services of a factory-authorized service representative for 8 hours to demonstrate alarm system start-up and shut-down procedures,

preventative maintenance and servicing procedures, and troubleshooting procedures. Review operating and maintenance information.

B. Coordinate time of demonstration and training with Owner's representative after system passes all inspections and is commissioned but before occupancy of facility. Provide at least 7-day written notice of availability of service representative to provide demonstration and training.

END OF SECTION 15485